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EVALUATION OF NORMAL FEMALE SUDANESE PELVIC ANATOMY USING MAGNETIC RESONANCE IMAGING (MRI)

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Abstract
Purpose: This study aims to investigate the dimensions of the bony pelvis and soft tissue structures and to characterize the normal gynaecological appearance of single Sudanese females using magnetic resonance imaging (MRI).
Design/methodology/approach: Seventy-two single females aged between 15 and 80 years were selected using Sagittal T_2-weighted pelvic MRIs of 1.5 tesla. The determined variables were uterine cervix cranio-caudal, uterus length, pelvis outlet, pelvic cavity and true conjugate, linearly correlated with age. Signal intensity was used to characterize the normal pelvis structures. For the bladder, uterus endometrium, myometrium, cervix, vagina, adenexa, ovaries, Sagittal T_1,T_2 and Coronal T_2-weighted images were used.
Findings: There were significant differences in Sudanese results when compared with Afro-American groups.
Originality/value: This study may contribute to obstetrics and gynaecology in the future.

Key words: MRI, Pelvis, Anatomy, Gynaecology

Paper type: Research paper

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INTRODUCTION

Magnetic resonance imaging (MRI) has become one of the primary imaging modalities for the pelvic area, which contains the reproductive organs (Wilkinson and Paley, 2008). MRI has several advantages over computed tomography (CT) and ultrasonography, including noninvasiveness, no ionizing radiation, multiplanar imaging without repositioning the patient, excellent tissue-differentiating capabilities without the use of contrast agents, sensitivity to flowing blood and characterization of biochemical states of blood. Such capabilities allow excellent study of normal and abnormal anatomy. Ultrasonography and CT scanning are the primary imaging modalities used in gynaecology. However, it is clear that MRI can serve as an alternative or an adjunctive tool in many instances (Kay and Sprinter, 2008).

Anatomically, four types of female pelvis were described: gynaecoid, anthropoid, android and platypelloid (Hamm and Forstner, 2007). Many factors may cause differences in gynaecological measurements, including secretory hormones, secretory phase, and contraceptive use (Hricak, 1986; Hricak *et al.*, 1988) and pelvis measurement including racial differences (Handa *et al.*, 2008).

In recent decades, MRI has become the imaging technology of choice for many gynaecologic diseases and has improved with the development of multicoils, high-resolution, fast spin-echo MR imaging, which allow a more detailed study of the reproductive organs (McCarthy, 1990).

As far as we know, no study has been published in the open literature regarding the pelvis and gynaecological measurement for Sudanese females. This study aims to evaluate the normal Sudanese female pelvis and gynaecological appearance using magnetic resonance imaging (MRI).

MATERIALS AND METHODS

This study was conducted in two hospitals in Khartoum State (Alzytona Specialist Hospital, Modern Medical Center) during the period from August 2010 to October 2011.

MRI MACHINE

General electric (GE) 1.5 T, manufacturing date: October 2010, made by GE/USA, SN-R 4559. Coil: body coil 8 channels, manufacturing date: October 2010, SN-50055, part number-1101501.

MRI machine 1.5 Tesla (Toshiba), SN/R3E0992016, Mn/MRT-1503, manufacturing date: September 2009, Coil: TARSO SPEEDER, SN/S1A0992734 manufacturing date: September 2009.

STUDY SAMPLE

A total of 72 single Sudanese females aged between 15 and 80 years old examined for MRI pelvis investigation were involved in this study.

EXCLUSION CRITERIA

Married, delivered, aborted females, and females with any gynaecological diseases, such as fibroids, masses, and females during menstruation were excluded.

TECHNIQUES

Patients were lying supine, feet first, with cushioned legs and arms folded to the chest. A body array coil was wrapped around the pelvis and the scanning protocol used for pelvic investigation was the standard protocol: Axial T_2w (TR 7100, TE 100), Axial T_1w (TR 630, TE 100), Sagittal T_2w fat/sat (TR 3600, TE 60), Sagittal T_2 (TR 7000, TE 100), Sagittal T_1w (TR 470, TE 15), Coronal T_2w (ovarian) (TR 5200, TE 120),Coronal T_2w (ovarian) TR 5200, TE 120).

METHODS OF MEASUREMENTS

The variables under study were: patient age, true conjugate (from the tip of the sacral promontory to the upper border of the symphysis pubis), and pelvic cavity (from the lower border of the second sacral to the midpoint of symphysis pubis), pelvic outlet (from the tip of the coccyx to the lower border of symphysis pubis), uterus length, and uterine cervix cranio-caudal. All measurements were performed in centimeters (cm). The applied measurements in MRI–mid-sagittal T2 weighted images through lower abdomen were similar to the methodology mentioned by Moeller and Reif (2000).

The uterus endometrium, myometrium, ovaries, cervix, vagina, bladder and pelvic musculature were all characterized in T1 and T2 axial, coronal and sagittal weighted images.

RESULTS

PELVIC MEASUREMENTS INTERPRETATION

This study includes 72 females of different ages ranging from 15–80 years. All of them were from Khartoum state, and single. MRI for pelvis was performed for the whole sample. The selected variables were: the pelvic cavity, the pelvic outlet, the true conjugate, uterus length, and uterine crevices cranio caudal. All the variables were correlated with the patient's age. The results included the mean and standard deviations of the variables as well as the relationship between the variables used in this study.

Age	Frequency	Percentage %
15–25	8	11.11
26–36	20	27.77
37–47	16	22.22
48–58	14	19.44
59–69	7	9.72
70–80	7	9.72

Table 1. Frequency and percentage of measurements in different age groups

	Variables					
	Patient age	Uterine cervix cranio-caudal	Uterus length	True conjugate	Pelvic cavity	Pelvic outlet
Mean	46.81	2.0	8.31	11.6	12.7	13.07
SD	±0.71	±1.01	±1.08	±0.72	±1.54	±0.71

Table 2. Sudanese measured variables and the mean and standard deviation

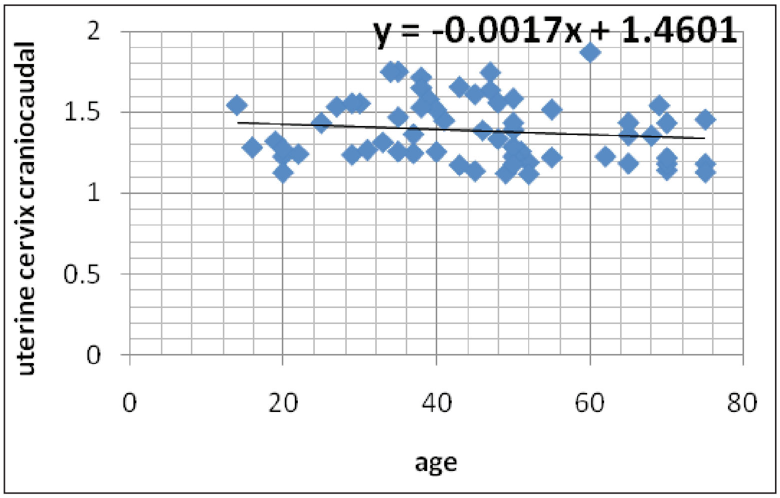

Figure 1. Linear association between uterine cervix caranio caudal and age with a trend line indicating a direct linear relationship. Uterine cervix caranio caudal decreased by 0.0017 per cm, starting from 1.46

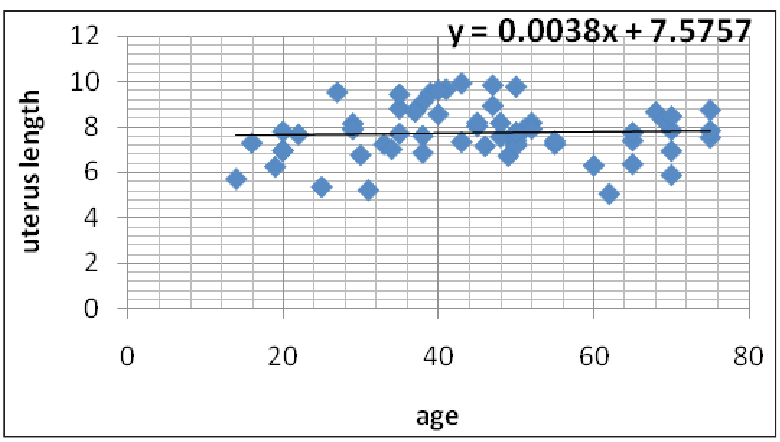

Figure 2. Linear association between uterus length and age with a trend line indicating a direct linear relationship. Uterus length increased by 0.0038 per cm, starting from 7.58

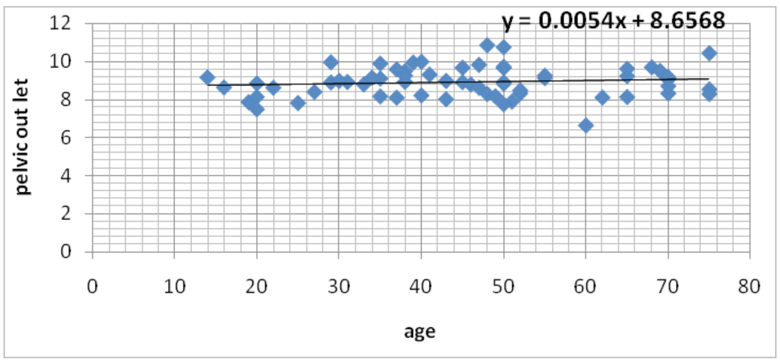

Figure 3. Linear association between pelvic outlet and age with a trend line indicating a direct linear relationship. Pelvic outlet increased by 0.0054 per cm, starting from 8.66

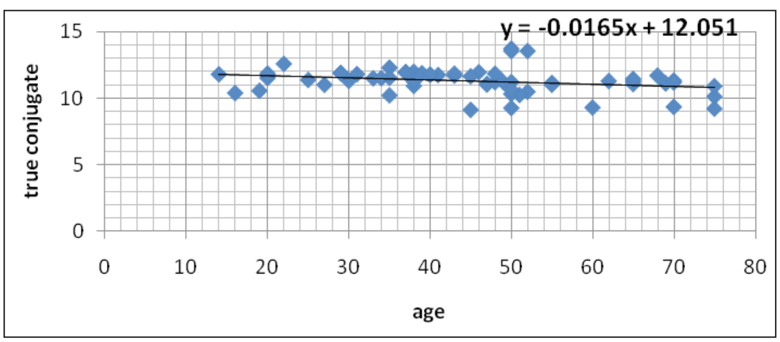

Figure 4. Linear association between true conjugate and age with a trend line indicating a direct linear relationship. True conjugate decreased by 0.0165 per cm, starting from 12.05

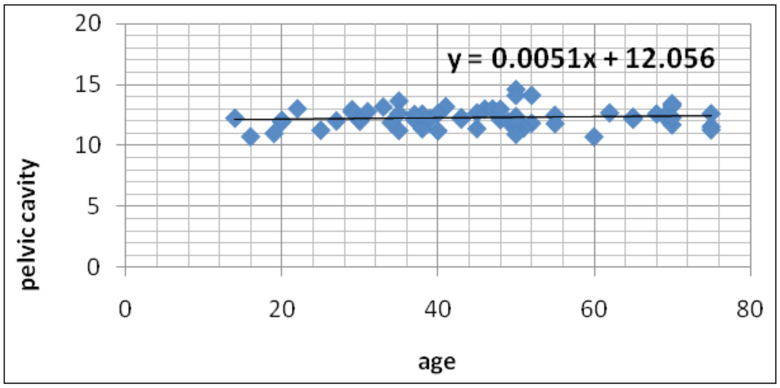

Figure 5. Linear association between pelvic cavity and age with a trend line indicating a direct linear relationship. True conjugate increased by 0.0051 per cm, starting from 12.05

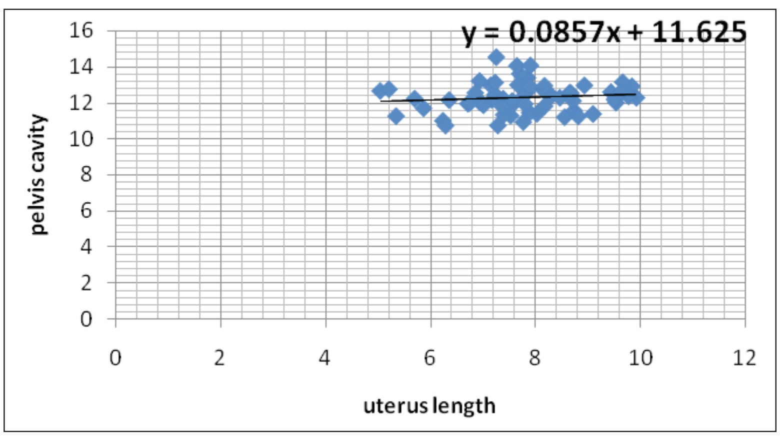

Figure 6. Linear association between pelvic cavity and uterus length with a trend line indicating a direct linear relationship. Pelvic cavity increased by 0.0857 per cm, starting from 11.63

CHARACTERIZATION OF NORMAL GYNAECOLOGY OF SINGLE SUDANESE FEMALES

In Sagittal T_1-weighted images of the uterus, differentiation between the endometrial tissue and the myometrium was difficult. The bladder fluid had hypo signal intensity compared to the fat. In Sagittal T_2-weighted images, the area between the myometrium and endometrium and cervix were of hypo signal intensity; the vagina had high signal intensity surrounded by an area of hypo signal intensity. The fluid in the bladder had high signal intensity. In Coronal T_2-weighted images, the adnexa were iso intense. The ovaries had hyper signal intensity when compared with fats.

DISCUSSION

The study used five variables, including uterine cervix cranio-caudal, uterus length, pelvic outlet, and pelvic cavity, true conjugate to account for the optimum measurements related to females' age. Using frequency (Table 1), which represents the age categorization, these data show that eight patients were females ranging between 15 and 25 years of age (11.11%), 20 patients were aged between 26 and 35 (27.8%), 16 patients were aged between 37 and 47 (22.22%), 14 patients were aged between 48 and 58 (19.4%), seven patients were aged between 59 and 69 (9.72%), and seven patients were aged between 70 and 80 (9.72%).

Moeller and Reif (2000) reported the standard female pelvic measurements for the same variables as ≤2cm, 8cm, 9cm, 12cm and

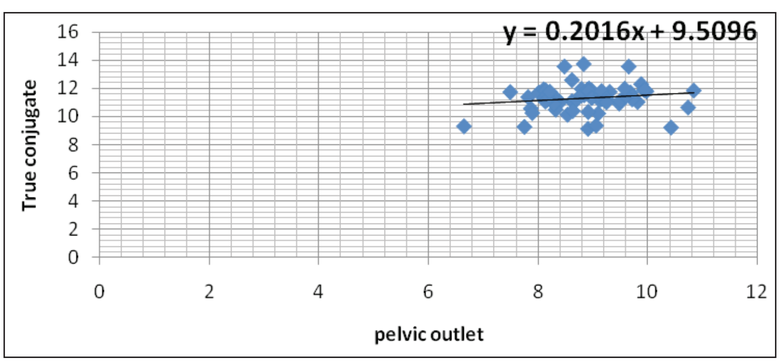

Figure 7. Linear association between pelvic outlet and the true conjugate, with a trend line indicating a direct linear relationship. True conjugate increased by 0.20 per cm, starting from 9.51

11cm respectively. The Sudanese female measurements in this study were found to be 2.0cm, 8.31cm, 13.07cm, 12.7cm and 11.6cm respectively. On comparing these findings, a significant difference was detected at p value 0.005.

Using stepwise linear regression, the variables were correlated with the females' age. The uterine cervix cranio-caudal and true conjugate measurements decreased as age increased by 0.0017 and 0.0165 respectively.

The pelvic outlet, uterus length and pelvic cavity measurements increased by 0.0038, 0.0054 and 0.0051 respectively when age increased because the uterus is markedly influenced by hormones and the follicular phase of the menstrual cycle.

The linear association between pelvic cavity and uterus length indicates a direct linear relationship: the pelvic cavity increased by 0.0857 per cm, with a starting point of 11.63. The linear association between pelvic outlet and the true conjugate indicates a direct linear relationship. The true conjugate increased by 0.20 per cm, with a starting point of 9.51.

Female pelvic measurements in Afro-American and white females were studied via MRI by Handa *et al.* (2008). The Afro-American group pelvic true conjugate and pelvic outlet were 10.0 ± 0.7cm and 11.8 ± 0.9cm respectively, whereas the white female group pelvic true conjugate and pelvic outlet were 10.7 ± 0.7cm and 12.3 ± 1.0cm respectively. In comparison, Sudanese female pelvic inlet and outlet measurements were greater than Afro-American and white females, which may be due to racial differences (Handa *et al.*, 2008).

Characterization of normal female gynaecology allows identification of pathologic alterations where the pelvic soft tissue structures change due to menstrual cycle phase, hormonal changes, and among patients who use oral contraceptives, primiparous women who delivered vaginally or women who underwent caesarean delivery (Handa *et al.*, 2008).

The female Sudanese MRI images were evaluated by one radiologist and two expert technologists. All the cases were evaluated using the terms hyper signal intensity, hypo signal intensity, iso signal intensity in both T_1 and T_2 weighted images. All the cases were obtained in the follicular phase by asking the patients about their last menstrual cycle. The sample contains females who were post-menopause; these subjects were excluded from image characterizations.

On T_1-weighted images, the uterus appears as a homogeneous structure of iso signal intensity. However, on T_2-weighted sequences, the uterine cervix is clear. The myometrium is of iso signal intensity, whereas the endometrium has high signal intensity; they are separated by an area of hypo signal intensity. This difference may be due to decreased fluid content (McCarthy *et al.*, 1989; McCarthy and Vaquero, 1986) as the structures within the uterus are markedly influenced by hormones. The study took place during the follicular phase, because females in this phase of the menstrual cycle demonstrate a thin endometrium and on T_2-weighted images, the signal intensity of the myometrium is hypo intense.

The cervix was evaluated on MRI T_2 weighting. The normal cervix has two separate areas: a central area of high signal intensity and an outer one of low signal intensity. On T_1-weighted images, the area surrounding the cervix is imaged as iso signal intensity.

Axial images are excellent in allowing identification of the vagina (Hricak, 1986). The vagina studied on axial T_2-weighted images has a hyper-intensity centre where the wall is of hypo signal intensity

Normal ovaries tend to have hypo to iso signal intensity on T_1-weighted images. On T_2-weighted images, they have greater hyper signal intensity than fats. This may be due to several small follicular cysts (McCarthy, 1990), hence the scanning in this study was done in the follicular phase.

The pelvic musculature is of hypo signal intensity compared with fat. The bladder and bony pelvis is identified in both T_1 and T_2 weighted images.

The study concluded that the Sudanese female has greater measurements for the pelvic inlet and outlet than Afro-American and white subjects. Significant differences were detected when compared with the standard radiological measurement. There is a correlation between age and pelvic outlet, uterus length, pelvic cavity uterine cervix cranio-caudal and true conjugate measurements.

Characterization of normal female gynaecology allows the identification of pathologic alterations. MRI can be used for obstetric pelvimetry, because no ionizing radiation is used.

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